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143. Proposed by F. P. MATZ, M. Sc., Ph. D., Professor of Mathematics and Astronomy in Irving College, Mechanicsburg, Pa.

A's income $=a/b$th part $=\frac{3}{4}$ of B's income. A's outgo $=m/n$th part $=\frac{1}{2}$ of B's income. B's outgo $=p/q$th part $=1/1$ of A's income. What is the ratio of their savings?

Solution by G. B. M. ZERR, A. M., Ph. D., Professor of Chemistry and Physics, The Temple College, Philadelphia, Pa.

A's outgo $=m/n$th of B's income.

A's saving $=\left(\frac{a}{b}-\frac{m}{n}\right)=\frac{an-bm}{bn}$ of B's income.

B's outgo $=ap/bq$th of B's income.

B's saving $=1-\frac{ap}{bq}=\frac{bq-ap}{bq}$ of his income.

$$\therefore \frac{an-bm}{bn}:\frac{bq-ap}{bq}=\frac{an-bm}{n}:\frac{bq-ap}{q},$$

but $a=3$, $b=4$, $m=p=q=1$, $n=2$.

$\therefore$ The ratio of their savings is 1:1.

ALGEBRA.

117. Proposed by G. B. M. ZERR, A. M., Ph. D., Professor of Chemistry and Physics, The Temple College, Philadelphia, Pa.

Rationalize $l^{\frac{1}{2}}+m^{\frac{1}{2}}+n^{\frac{1}{2}}+x^{\frac{1}{2}}+y^{\frac{1}{2}}+z^{\frac{1}{2}}=0$.

Solution by the PROPOSER.

Let $u^6+pu^4+qu^3+ru^2+su+t=0$, be the equation having $l^{\frac{1}{2}}$, $m^{\frac{1}{2}}$, $n^{\frac{1}{2}}$, $x^{\frac{1}{2}}$, $y^{\frac{1}{2}}$, $z^{\frac{1}{2}}$ for its roots; then $u^3+pu^2+qu^{\frac{3}{2}}+ru+su^{\frac{1}{2}}+t=0$ is the equation having l, m, n, x, y, z for its roots.

$$\therefore u^3+pu^2+ru+t+u^{\frac{1}{2}}(qu+s)=0$$

$$\text{or } u^6+2pu^5+(p^2+3r)u^4+(2t+2pr-q^2)u^3$$
$$+(r^2+2pt-2qs)u^2+(2rt-s^2)u+t^2=0.$$

Let $a=l+m+n+x+y+z=\Sigma(l)$.

$b=lm+ln+lx+ly+lz+mn+mx+my+mz+nx+ny+nz+xy+xz+yz=\Sigma(lm)$.

$c=lmn=lmx+lmy+lmz+lnx+lny+lnz+lxy+lxz+lyz+mnx+mny+mnz+mxy+mxz+myz+nxy+nxz+nyz+xyz=(\Sigma(lmn)$.

$d=lmnx+lmny+lmnz+lnxy+lnxz+lxyz+lmxy+lmxz+lmyz+lnyz+lxyz+lmxy+lmxz+lmyz+mnxy+mnxz+mnyz+mxyz+nxyz=\Sigma(lmnx)$.

$e=lmnxy+lmnxz+lmnyz+lnxyz+lmxyz+mnxyz=\Sigma(lmnxy)$.

$f=lmnxyz$.

Then $a=2p$, $b=p^2+2r$, $c=2t+2pr-q^2$, $d=r^2+2pt-2qs$, $e=2rt-s^2$, $f=t^2$.

$\therefore p=\frac{1}{2}a$, $r=\frac{1}{8}(4b-a^2)$, $q^2=\frac{1}{8}(16t+4ab-a^3-8c)\,..(1)$, $s^2=\frac{1}{4}(4bt-a^2t-4e)\,..(2)$.

$qs=(16b^2-8a^2b+a^4+64at-64d)/128\,....(3)$.

$(1)\times(2)=[(3)]^2$.

$\therefore\ [(16b^2-8a^2b+a^4-64d)/128]^2+(at/128)(16b^2-8a^2b+a^4-64d)$ $+\frac{1}{4}a^2t^2=(64bt^2-16a^2t^2-16abe+4a^3e+32ce)/32+(16ab^2-4a^3b-32bc-4a^3b+$ $a^5+8a^2ct-64e)t/32$.

But $f=t^2$.

$\therefore\ [(16b^2-8a^2b+a^4-64d)/128]^2+(96a^2f-256bf+64abe-16a^3e-128ce)$ $/128=(48ab^2-24a^3b-256e-128bc+3a^5+32a^2c+64ad)t/128$.

$\therefore\{(16b^2-8a^2b+a^4-64d)^2+[128(96a^2f-256bf+64abe-16a^3e-128ce)]\}^2$ $=[128(48ab^2-24a^3b+3a^5+32a^2c+64ad-128bc-256e)]^2f$.

The values of a, b, c, d, e, f in this last equation is the rationalized form in full.

Also solved by *ELMER SCHUYLER*.

118. Proposed by FREDERIC R. HONEY, Ph. B., Instructor at Trinity College, and Lecturer at Smith College, New Haven, Conn.

An army whose length is equal to a, moves forward. An officer is sent from the rear to the van, and is required to present himself at the rear again when the rear has reached the point where the van was when the army began to move. How far did the officer travel?

I. Solution by H. C. WHITAKER, A. M., Ph. D., Manual Training School, Philadelphia, Pa.; S. F. NORRIS, Baltimore City College. Baltimore, Md.; C. E. ARMENTROUT, Rockingham Military Institute, Mt. Crawford, Va.; J. W. YOUNG, Cornell University, Ithaca, N. Y.; M. E. GRABER, Heidelberg University, Tiffin, Ohio; P. S. BERG, Larimore. N. D.; J. F. TRAVIS, Student Ohio State University, Columbus, O.; MARTIN J. SPINKS, Wilmington, O.; and the PROPOSER.

When the officer moves forward $a+x$, the army goes x; when the officer moves backward x, the army goes $a-x$.

Therefore, $\dfrac{a+x}{x}=\dfrac{x}{a-x}$, whence $x=\dfrac{a}{\sqrt{2}}$.

Whole distance traveled by the officer$=a+2x=a(1+\sqrt{2})$.

II. Solution by C. HORNUNG, A. M., Heidelberg University, Tiffin, O.; D. G. DORRANCE, Jr., Camden, N. Y.; JOSIAH H. DRUMMOND, LL. D., Portland, Me.; and the late SYLVESTER ROBINS, North Branch, N. J.

Let x=officer's rate and y the army's rate of travel.

Then $\dfrac{a}{x-y}+\dfrac{a}{x+y}=\dfrac{a}{y}$. Whence $x=y(1\pm\sqrt{2})$, or $x/y=1+\sqrt{2}=2.414+$ that is, the officer travels 2.414 times as fast as the army, and, therefore, 2.414 times as far. Therefore the officer travels $(1+\sqrt{2})a$.

Also solved by *J. SCHEFFER*, *COOPER D. SCHMITT*, *H. C. WILKES*, and *G. B. M. ZERR*.